

stratification is regular, parallel, and continuous. Tidal flats are characterized by very thick channel cross-beds, thin irregular beds containing organism burrows and trails, and shale-pebble conglomerate. Beach deposits consist of tabular to wedge-shape bundles of thin, regular, parallel to subparallel to laminae. Surf-zone deposits contain low-angle cross-beds in tabular to irregular, relatively continuous sets 1 ft. thick or less.

30. R. E. SWENSON, Chevron Oil Company, Billings, Montana

TRAP MECHANISMS IN NISKU IN NORTHEASTERN MONTANA

The Upper Devonian Nisku Formation became a productive unit for the first time in late 1960, when the Tule Creek field was discovered in northeastern Montana. Since then 6 additional Nisku fields have been discovered within a 10-mi. radius of Tule Creek. Even-textured, saccharoidal dolomite, which has 50 ft. of net pay, is productive of 40°-47° API oil at these 7 fields.

Data from closely spaced wells amply demonstrate that structural closure is the basic trapping mechanism for oil in the Nisku. Various interpretations have been advanced regarding the type and degree of influence of stratigraphic factors in these accumulations. Current information indicates that primary stratigraphic variations do impose a semi-regional control on the entrapment of oil in the Nisku, but are less important in individual traps.

Steep-sided, flat-topped structures, which typically are less than 1 sq. mi. in area, control the limits of Nisku fields. The writer suggests that the structures are not the products of normal tectonics. Instead, it can be demonstrated, both theoretically and by deep-well data, that the structures are "sedimentary structures" resulting from multiple-stage solution of the Lower Devonian Elk Point salt beds.

The present-day solutional zero edge of the Elk Point salt beds is east of and down-dip from the Nisku fields. The writer suggests that an original thickness of 50-100 ft. of salt was present in the Tule Creek area, and that the original depositional edge of the salt was farther west.

31. GRAHAM S. CAMPBELL, Consulting geologist, Salt Lake City, Utah

DOUGLAS CREEK TREND, CASE HISTORY, UINTEA BASIN, UTAH

The 75-mi.-long productive fairway of the Douglas Creek Member of the Green River Formation yields 7 million bbls. of oil and 1 Bcf. of gas annually, largely from two fields. It was not until 13 yrs. after discovery that geologists recognized the broad extent and stratigraphic nature of the accumulation along this trend. A more determined and subjective examination of the specific pay unit, ignoring shows in other Green River members, would have resulted in a much earlier definition of the trend.

Subsidence during Douglas Creek time, transverse to usual northwest-striking Green River stratigraphic trends, caused a temporary but significant shift in shore alignment. The Douglas Creek lake-margin sandstone bodies, which are more "marine" than deltaic in character, trend southwestward.

Recent definitive studies to understand the Douglas Creek trend should hasten new and substantial discoveries along it.

32. A. V. ROBERTSON COE, District geologist, Husky Oil Company, Cody, Wyoming

PITCHFORK OIL FIELD, PARK COUNTY, WYOMING

The Pitchfork oil field, discovered in 1930, is on a steeply dipping, surface-anticlinal structure along the west flank of the Big Horn basin, Park County, Wyoming. The discovery well was completed at a total depth of 3,903 ft. in the Tensleep Sandstone. Field production today is primarily from the Tensleep, though a small amount of production is from the Permian Phosphoria Formation. One well was drilled in 1962 to test older formations, and reached a total depth of 7,766 ft. in the Precambrian.

The original oil found in the discovery well was 18° API. Because of the lack of demand for such oil, poor transportation, and low prices, the well was shut in until 1944. Development since 1944 has been sporadic.

The Tensleep is 250-275 ft. thick, and consists of porous, very fine- to fine-grained, heavily oil-saturated sandstone bodies separated by tight, slightly oil-saturated sandy dolomite and dolomite lenses. Within this active water-drive field, there is 130-150 ft. of net pay having permeability in excess of 25 md. and porosity in excess of 10%. As many as 5-6 zones in the field are characterized by such values. However, as development progressed, it became apparent that "pods" of oil were not being drained effectively by updip wells because of the irregular permeability and porosity.

High water cuts are found in low-permeability sandstone beds where the highly viscous oil is bypassed, and in high-permeability fractured zones where communication is established early with down-dip, higher water saturations.

The upper part of the Phosphoria Formation contributes 15-20 b/d of oil from 3 dually completed wells. The 30 ft. of crystalline, vuggy, fossiliferous, heavy-oil-saturated Phosphoria dolomite has a porosity range of 14 to 23%, but low permeability reduces the effectiveness of the water drive and results in low fluid recovery.

Development drilling continues within the Pitchfork Unit in the oil-water transition zone because the economic productive limits are undefined.

As of January 1, 1966, 37 wells were producing at the rate of 103,000 bbls. of oil per month from 720 acres on a 23-acre-spacing pattern. Cumulative production to January 1, 1966, was 8,600,000 bbls. of oil and 30,000,000 bbls. of water.

33. JERRY L. BRANCH, Consulting geologist, Shelby, Montana

GENERAL DRILLING HISTORY AND NEW DEVELOPMENTS IN NORTHWESTERN MONTANA

Northwestern Montana is geologically complex, and this complexity is fully reflected in the diversity of type and location of oil and gas accumulations. As a result, the oil and gas history of this area has been one of continual development of new and changing geological ideas.

Until 1963, drilling was concentrated primarily in and around old productive areas associated directly with the Sweetgrass arch. Subsequently, new discoveries essentially were extensions to already productive Cretaceous Cutbank sandstone and Madison carbonate reservoirs in the Cutbank, Kevin-Sunburst, and Pondera fields.

The present-day drilling boom is a product of new stratigraphic ideas in the shallower Cretaceous Sunburst and Moulton sandstone units. These ideas and improved drilling economics were spawned by several recent wildcat wells. Well completions to date have increased the annual production in northwestern Montana from 4 to more than 6.5 million bbls. of oil in less than 3 yrs.

34. KENNETH E. CARTER, Consultant, Durango, Colorado

CACHE FIELD, MONTEZUMA COUNTY, COLORADO

The Cache field in southwestern Colorado is the most productive field in the Colorado part of the Paradox basin. The field was discovered in October, 1964, and currently there are 18 producing wells with 40-acre spacing. Gas and high-gravity oil are produced from limestone and dolomite in the Ismay zone (Pennsylvanian) at a depth of 5,600 ft. Within the productive intervals, average porosity is 8-10% and average permeability is 20-25 md. The average net-pay thickness is approximately 40 ft. and there have been initial flowing potentials in excess of 3,000 b/d of oil.

The productive area trends northwest, is 2 mi. long by 1/2 mi. wide, and encompasses 740 acres. Subsurface control indicates the existence of approximately 50 ft. of closure at the top of the Ismay zone. However, the accumulation is controlled primarily by the development of porosity and permeability within "stacked" algal bioherms which grade laterally into anhydrite.

Cumulative production to May 1, 1966, was 1,519,251 bbls. of oil. Estimated recoverable reserves are 4.6 million bbls. of oil.

35. D. KEITH MURRAY, Consulting geologist, AND LOUIS C. BORTZ, Pan American Petroleum Corporation, Denver, Colorado

EAGLE SPRINGS FIELD, NEVADA

Shell Oil Company discovered Eagle Springs oil field, Nevada's sole producing area, in 1954. Since late 1963, Texota Oil Company and Western Oil Lands have extended production more than 1 mi. east, completing several prolific wells (up to 1,000 b/d). To date, the productive limits of the field have not been defined entirely. Shell's discovery was drilled on a seismic anomaly reportedly mapped in Miocene valley-fill deposits. Cumulative production to April 1, 1966, is 1,208,530 bbls. of oil, with proved recoverable reserves from 13 productive wells estimated at 10,000,000 bbls.

Most of the production is from carbonates of the Eocene Sheep Pass Formation and from porous zones in Oligocene welded tuffs. A well in the southwest part of the field has produced a small amount of oil from Pennsylvanian(?) carbonate. The Sheep Pass Formation, which is characterized by the absence of volcanic material, was deposited in a local lacustrine basin that covered parts of the present-day Railroad Valley, White River Valley, and adjacent mountain ranges. The Oligocene welded tuffs are part of an extensive ignimbrite sequence that once covered much of Nevada and western Utah. The pay zones in the field are discontinuous, being absent both in some of the Eagle Springs Unit wells and in several of the exploratory tests drilled in the region. However, a significant percentage of wells drilled in east-central Nevada has found hydrocarbon shows in both Tertiary and Paleozoic sediments.

The oil trap at Eagle Springs appears to result from a combination of faulting, folding, truncation, and overlap; impermeable Miocene fanglomerate overlaps truncated Oligocene and Eocene reservoir beds along a northwest-plunging anticlinal nose, as mapped at the base of the Miocene valley fill. Closure on the east is provided in part by a major boundary-fault zone exhibiting 10,000-15,000 ft. of apparent stratigraphic displacement. This fault zone separates the field from the uplifted Grant Range on the east.

Although a fairly complete Paleozoic succession has been mapped in nearby mountain ranges, much of that section is absent in some of the Railroad Valley wells. For example, Mississippian overlies Cambrian in Shell's discovery well, probably because of pre-Eocene faulting. Within the central part of the "Sheep Pass basin," little or no angular discordance separates the Eocene from the upper Paleozoic sediments. However, at the edge of this depositional basin, these same rock units are separated by a distinct angular unconformity. Oligocene pyroclastic rocks disconformably overlie Eocene Sheep Pass sediments both in the field and at most observed outcrops within the "Sheep Pass basin." Basin-and-range normal faulting began during late Oligocene or early Miocene time. Movement along these faults continued at least until the end of the Tertiary. A quartz monzonite intrusive body which was penetrated in Shell's discovery well is of Miocene age as determined by K-Ar dating methods.

It is logical to assume that additional significant oil accumulations will be found in eastern Nevada. However, in order to discover them, a coordinated exploration program is required.

CERTIFICATION APPLICATIONS APPROVED FOR PUBLICATION

The executive committee has approved for publication the names of the following candidates for Certification as Petroleum Geologists. This does not constitute certification but, in accordance with certification procedures, places the names of the candidates and sponsors before the membership for a period of sixty days. If any member has information bearing on the qualifications of these candidates, it should be sent promptly to the Executive Committee, Box 979, Tulsa, Oklahoma 74101.

Bell, Forrest William, Midroc Oil Corp., Shreveport, La.
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